

**UNITED STATES AIR FORCE
ARMSTRONG LABORATORY**

**Health Risk Assessment At Air Force
Plant 6, Marietta, GA**

**Brian L. Sassaman, Captain, USAF
G. Cornell Long**

February 1997

DTIC QUALITY INSPECTED 2

19970324 054

*Approved for public release;
distribution is unlimited.*

**Occupational and Environmental Health
Directorate
Occupational Medicine Division
2402 E Drive
Brooks AFB, TX 78235-5114**

NOTICES

This technical report is published as received and has not been edited by the staff of the Armstrong Laboratory.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement operation, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder or any other person or corporation; or as conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

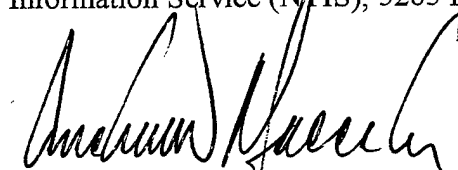
The mention of trade names or commercial products in this publication is for illustration purposed and does not constitute endorsement or recommendation for use by the United States Air Force.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

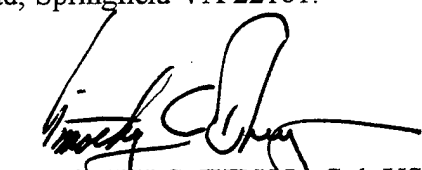
This report has been reviewed and is approved for publication.

Government agencies and their contractors registered with the Defense Technical Information Center (DTIC) should direct requests for copies to: DTIC, 8725 John J. Kingman Rd Ste 0944, Ft. Belvoir, VA 22060-6218.

Non-Government agencies may purchase copies of this report from: National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield VA 22161.



ANDREW T. MACCABE, Maj, USAF, BSC
Chief, Health Risk Assessment Branch



TIMOTHY C. IHRY, Col, USAF, BSC
Chief, Occupational Medicine Division

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE February 1997	3. REPORT TYPE AND DATES COVERED Final October - December 1996		
4. TITLE AND SUBTITLE Health Risk Assessment at Air Force Plant 6; Marietta, GA		5. FUNDING NUMBERS		
6. AUTHOR(S) Captain Brian L. Sassaman Mr. G. Cornell Long				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Armstrong Laboratory (AFMC) Occupational and Environmental Health Directorate Occupational Medicine Division 2402 E Drive Brooks AFB, TX 78235-5114		8. PERFORMING ORGANIZATION REPORT NUMBER AL/OE-TR-1996-0163		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) This report evaluates the potential for health impact from various volatile organic compounds (VOCs) to students at Southern Polytechnical College that may come in contact with water in Rottenwood Creek. Rottenwood Creek is in part fed by two streams that flow offsite from two retention basins located on Air Force Plant 6 (AFP 6), Marietta, Georgia. The evaluation was requested by Aeronautical System Center/Environmental Management Restoration (ASC/EMR). The evaluation uses the existing Environmental Protection Agency (EPA) "Risk Assessment Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)", EPA/540/1-89-002. Based on the evaluation, the potential exposure and associated health risks to students are negligible and the water is safe.				
14. SUBJECT TERMS Risk Assessment Volatile Organic Compounds		15. NUMBER OF PAGES 24		
		16. PRICE CODE		
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

TABLE OF CONTENTS

INTRODUCTION	1
METHODS	1
<u>BACKGROUND</u>	1
<u>DATA COLLECTION AND EVALUATION</u>	1
<u>EXPOSURE ASSESSMENT</u>	2
<u>TOXICITY ASSESSMENT</u>	3
<u>RISK CHARACTERIZATION</u>	4
<i>Carcinogenic Effects</i>	4
<i>Noncarcinogenic effects</i>	4
RESULTS	5
DISCUSSION	9
UNCERTAINTIES	9
RECOMMENDATIONS	10
REFERENCES	11
APPENDIX 1. SAMPLING LOCATIONS ALONG ROTTENWOOD CREEK AND TRIBUTARIES	13
APPENDIX 2: HISTORICAL DATA, FOR IRRIGATION WELL AND NEARBY TRIBUTARIES	15

Acknowledgements

Special thanks goes to Mr. Steven Cobb of Air Force Plant 6, Marietta, GA along with Mr. Greg Harvey and Mr. David Brucker of Aeronautical Systems Command, Environmental Management for their assistance in providing information for this technical report.

INTRODUCTION

This report evaluated the potential for health impact from various volatile organic compounds (VOCs) to students at Southern Polytechnical College that may come in contact with water in Rottenwood Creek. Rottenwood Creek is in part fed by two streams that flow offsite from two retention basins located on Air Force Plant 6 (AFP 6), Marietta, Georgia. The evaluation uses existing Environmental Protection Agency (EPA) guidance. Based on the evaluation, the potential exposures and associated health risks to students are negligible and the water is safe.

METHODS

Background

Mr. David Brucker of Aeronautical System Center/Environmental Management Restoration (ASC/EMR) requested the Health Risk Assessment Branch at Armstrong Laboratory (AL/OEMH) evaluate exposures to VOCs in water found in Rottenwood Creek. The purpose of performing a risk assessment was to determine the likelihood that people living, working, or playing at or near the site may experience health problems as a result of their exposure to chemicals in the creek. A traditional risk assessment paradigm is composed of four components: **Data Collection and Evaluation, Exposure Assessment, Toxicity Assessment, and Risk Characterization.** Typically, remedial actions use a simplified construct, where: $RISK = Toxicity \text{ and } Exposure$. This report attempts to follow the risk assessment paradigm. Since AFP 6 is located in EPA Region IV, the Region IV Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS) was followed where applicable.

There are two streams that flow offsite from AFP 6 retention basins (Appendix 1). These streams combine into Rottenwood Creek, travel across the college campus, and eventually discharge into the Chatahoochee River. In Jan 95, an irrigation water well and the streams on the campus were tested and found to have elevated levels of VOCs. The Air Force initiated an offsite contaminate groundwater investigation which is currently underway. During a Mar 96 public meeting at AFP 6, the environmental coordinator for the college questioned the safety of the water in Rottenwood Creek. He stated that students occasionally go into the Creek, and he was concerned about the health effect of the contaminants in water on them. The Air Force agreed to conduct a risk assessment to address this issue. A future public meeting for AFP 6 was tentatively scheduled to respond to the question of safety of the water.

Data Collection and Evaluation

Data collection and evaluation attempts to answer the questions, "What are the contaminants of concern?" and "Where is the contamination?" For AFP 6, surface water concentrations collected for Rottenwood Creek and tributaries 1 and 2 in 1994 are

presented in Appendix 2. Chemical concentrations used in the risk assessment are in bold type. The reason for using the bolded concentrations was to identify the contaminants that had the most likely potential for human contact. The most likely point of contact was identified along Rottenwood Creek; therefore, where concentrations were available, concentrations for Rottenwood Creek were used. Where the level was non detect (nd), the highest level from tributary 1 or 2 was used.

Exposure Assessment

Exposure assessment attempts to answer the questions, "How do people come in contact with the contaminants?" and "How much exposure is involved?" The Environmental Protection Agency's Risk Assessment Guidance for Superfund (RAGS) was used for the risk assessment employing a modified adult recreational exposure scenario for the Southern Polytech College student population. In addition, three exposure pathways were calculated: surface water ingestion, surface dermal contact, and ambient air inhalation. Both the carcinogenic (life time average daily dose - LADD) and noncarcinogenic (chronic daily dose - CDD) intakes or doses were calculated using the following equations.

Intake Equation (ingestion)	Intake Equation (dermal)	Intake Equation (inhalation)
$I = \frac{C \times IR \times EF \times ED}{BW \times AT}$	$I = \frac{C \times SA \times PC \times CD \times EF \times 1E-3}{BW \times AT}$	$I = \frac{C \times IR \times EF \times ED}{BW \times AT}$
I = intake (mg/kg body weight)	I = intake (mg/kg body weight)	I = intake (mg/kg body weight)
C = chemical concentration	C = chemical concentration	C = inhalation rate
IR = ingestion rate	SA = surface area	IR = inhalation rate
EF = exposure frequency	PC = partition coefficient	EF = exposure frequency
ED = exposure duration	EF = exposure frequency	ED = exposure duration
BW = body weight	CD = contact duration	BW = body weight
AT = averaging time	BW = body weight	AT = averaging time
	AT = averaging time	
	1E-3 = conversion factor	

The following tables summarize the exposure assumptions used in the general intake equation, linear low-dose cancer risk equation, and the noncancer hazardous quotient equation.

Adult recreational surface water ingestion			
Ingestion Rate	L/d	0.01	default value USEPA
Exposure Frequency	d/y	32	1 exposure per week for 16 weeks for 2 semesters
Exposure Duration	y	4	exposure duration at a 4 year college
Body Weight	kg	70	default value USEPA
Averaging Time carc.	d	25550	default value USEPA (365 days/year x 70 years)
Averaging Time noncarc.	d	730	value based on 365 days/year for 2 years

Adult recreational surface water dermal contact			
Surface Area	cm ²	6360	default value USEPA (surface area of legs and feet)
Exposure Frequency	d/y	32	1 exposure per week for 16 for 2 semesters
Exposure Duration	y	4	exposure duration at a 4 year college
Body Weight	kg	70	default value USEPA
Averaging Time carc.	d	25550	default value USEPA (365 days/year x 70 years)
Averaging Time noncarc.	D	730	value based on 365 days/year for 2 years
Swimming Duration	h/d	1	based on 1 hour duration in water
Permeability Coefficient	cm/h	0.02	chemical specific USEPA Exposure Factor Handbook

Adult recreational surface water inhalation			
Inhalation Rate	m ³ /d	2.5	default value USEPA Exposure Factor Handbook for moderate activity pattern
Exposure Frequency	d/y	32	1 exposure per week for 16 weeks for 2 semesters
Exposure Duration	y	4	exposure duration at a 4 year college
Body Weight	kg	70	default value USEPA
Averaging Time carc.	d	25550	default value USEPA (365 days/year x 70 years)
Averaging Time noncarc.	d	730	value based on 365 days/year for 2 years

Toxicity Assessment

The toxicity assessment attempts to answer the questions, "What are the main health effects?" and "What levels are safe?" The toxicity values used were based on oral (ingestion), dermal, and inhalation exposure pathways. These values were taken from the preliminary remediation goals (PRGs) for Regions III and IX. Toxicological references referenced in the PRGs come primarily from the Integrated Risk Information System (IRIS) and are shown below. For those chemicals where there is no slope factor or reference dose, that information is either not available, is pending, or the chemical is not considered a carcinogen. For the special case of trichloroethylene, the number has been retracted from IRIS due to the lack of consensus from the scientific community, but it continues to be used due to non-availability of any other data.

Chemical of Concern	Slope Factor (ingestion)	Reference Dose (ingestion)	Slope Factor (oral)	Reference Dose (oral)
Tetrachlorethylene	2.00E-03	1.00E-02	5.20E-02	1.00E-02
Trichloroethylene	6.00E-03	6.00E-03	1.10E-02	6.00E-03
1,1-Dichloroethylene	1.80E-01	9.00E-03	6.00E-01	9.00E-03
Tran-1,2-Dichloroethene		2.00E-02		2.00E-03
Cis-1,2-Dichloroethene		1.00E-02		1.00E-02
Bromodichloromethane	6.20E-02	2.00E-02	6.20E-02	2.00E-02
Chloroform	8.10E-02	1.00E-02	6.10E-03	1.00E-02
1,1-Dichloroethane		1.40E-01		1.00E-01
1,2-Dichloropropane	6.80E-02	1.10E-03	6.80E-02	1.10E-03
Vinyl Chloride	3.00E-01		1.90E+00	
Benzene	2.90E-02		2.90E-02	

Risk Characterization

Risk characterization integrates information from the preceding components of the risk assessment and synthesizes an overall conclusion about the risk. Steps for quantifying risk or hazard indices for both carcinogenic and noncarcinogenic effects are applied to each exposure pathway and analyzed.

Carcinogenic Effects

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. The slope factor converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer. EPA guidance assumes a linear dose-response relationship due to the relatively low exposure levels found at Superfund sites; therefore, the slope factor is a constant, and risk will be directly related to intake. Under this assumption the linear low-dose equation for a single chemical is described below.

$$\text{Risk} = \text{LADD} \times \text{SF}$$

where:

Risk = a unitless probability (e.g., $2.0\text{E-}5$) of an individual developing cancer

LADD = life time average daily dose averaged over 70 years (mg/kg-day)

SF = slope factor, expressed in $(\text{mg/kg-day})^{-1}$

Next, the risk calculated for each chemical of concern is summed together for a total risk per exposure pathway. The cancer risk equation shown below estimates the incremental individual lifetime risk for simultaneous exposure to several carcinogens and accounts for the joint probabilities of the same individual developing cancer as a consequence of exposure to two or more carcinogens.

$$\text{Total Risk} = \text{Risk}_1 + \text{Risk}_2 + \text{Risk}_3 \dots \text{Risk}_i$$

where:

Total Risk = the total cancer risk, expressed as a unitless probability

Risk i = the calculated risk for each chemical of concern

Noncarcinogenic effects

The measure used to describe the potential for noncarcinogenic toxicity to occur in an individual is not expressed as the probability of an individual suffering an adverse effect. The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is called a hazard quotient and is described below.

Noncancer Hazard Quotient = E/RfD

where:

E = exposure level (or chronic daily dose)

RfD = reference dose

E and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term)

The noncancer hazard quotient assumes that there is a level of exposure (i.e., RfD) below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level (E) exceeds this threshold (i.e., if E/RfD exceeds unity), there may be concern for potential noncancer effects. The level of concern does not increase linearly as the RfD is approached or exceeded because RfDs do not have equal accuracy or precision and are not based on the same severity of toxic effects. Thus, the slope of the dose-response curve in excess of the RfD can range widely depending on the substance.

To assess the overall potential for noncarcinogenic effects posed by more than one chemical a hazard index (HI) approach is used. This approach assumes that simultaneous subthreshold exposures to several chemicals could result in an adverse health effect. It also assumes that the magnitude of the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures to acceptable exposures. The hazard index is equal to the sum of the hazard quotients as shown below.

$$\text{Hazard Index} = E_1/\text{RfD}_1 + E_2/\text{RfD}_2 + E_i/\text{RfD}_i$$

where:

E_i = exposure level (or chronic daily dose)

RfD_i = reference dose for the *i*th toxicant

When the hazard index exceeds unity (1), there may be concern for potential health effects. While any single chemical with an exposure level greater than the toxicity value will cause the hazard index to exceed unity, for multiple chemical exposures, the hazard index can also exceed unity even if no single chemical exposure exceeds its RfD.

RESULTS

The excess cancer risk and noncancer risk to students was calculated for each chemical and then summed together to determine the total pathway risk and pathway hazardous index. This was done for surface water ingestion, surface water dermal contact, and inhalation of volatiles from surface water. The results for ingestion, dermal contact, and inhalation are displayed below in Tables 1, 2, and 3.

Table 1. Adult Recreational Surface Water Ingestion

Daily Dose (LADD or CDD) = (RME Conc. x IR x EF x ED) / (BW x AT) Carcinogenic risk = LADD x Slope Factor Hazard Quotient = CDD / Reference Dose					
Contaminant	RME Conc. mg/L	Lifetime Average Daily Dose mg/kg/d	Chronic Daily Dose mg/kg/d	Lifetime Cancer Risk	Systemic Hazard Quotient
Tetrachloroethylene	1.11E-03	7.87E-10	1.38E-08	409E-11	1.38E-06
Trichloroethylene	4.10E-04	2.93E-11	5.14E-09	3.23E-12	8.56E-07
1,1-Dichloroethylene	1.20E-04	8.59E-11	1.50E-09	5.15E-11	1.67E-07
Trans-1,2-Dichloroethene	3.60E-04	2.58E-10	4.51E-09	0.00E+00	2.25E-07
Cis-1,2-Dichloroethene	1.20E-04	8.59E-11	1.50E-09	0.00E+00	1.50E-07
Bromodichloromethane	1.40E-04	1.00E-10	1.75E-09	6.21E-12	8.77E-08
Chloroform	1.10E-04	7.87E-11	1.38E-09	4.80E-12	1.38E-07
1,1-Dichloroethane	4.20E-04	3.01E-10	5.26E-09	0.00E+00	5.26E-08
1,2-Dichloropropane	1.20E-04	8.59E-11	1.50E-09	5.84E-12	1.37E-06
Vinyl Chloride	1.39E-03	9.95E-10	1.74E-08	1.89E-09	0.00E+00
Benzene	1.80E-04	1.29E-10	2.25E-09	3.74E-12	0.00E+00
Total Pathway Risk				2.01E-09	
Pathway Hazard Index					4.42E-06

Table 2. Adult Recreational Surface Water Dermal Contact

Daily Dose (LADD or CDD) = (RME Conc. x SA x PC x CD x EF x ED x 1E-3 l/ml) / (BW x AT) Carcinogenic Risk = LADD x Slope Factor Hazard Quotient = CDD/Reference Dose						
Contaminant	RME Conc. mg/L	Lifetime Average Daily Dose mg/kg/d	Chronic Daily Dose mg/kg/d	Dermal Permeability Coeff. cm/h	Lifetime Cancer Risk	Systemic Hazard Quotient
Tetrachloroethylene	1.11E-03	2.40E-08	4.21E-07	4.80E-02	1.25E-09	4.21E-05
Trichloroethylene	4.10E-04	2.99E-09	5.23E-08	1.60E-02	3.28E-11	8.71E-06
1,1-Dichloroethylene	1.20E-04	8.74E-10	1.53E-08	1.60E-02	5.24E-10	1.70E-06
Tran-1,2-Dichloroethene	3.60E-04	3.28E-09	5.74E-08	2.00E-02	0.00E+00	2.87E-06
Cis-1,2-Dichloroethene	1.20E-04	1.09E-09	1.91E-08	2.00E-02	0.00E+00	1.91E-06
Bromodichloromethane	1.40E-04	3.70E-10	6.47E-09	5.80E-03	2.29E-11	3.23E-07
Chloroform	1.10E-04	4.46E-10	7.80E-09	8.90E-03	2.72E-11	7.80E-07
1,1-Dichloroethane	4.20E-04	1.70E-09	2.98E-08	8.90E-03	0.00E+00	2.98E-07
1,2-Dichloropropane	1.20E-04	5.46E-10	9.56E-09	1.00E-02	3.71E-11	8.69E-06
Vinyl Chloride	1.39E-03	4.62E-09	8.08E-08	7.30E-03	8.78E-09	0.00E+00
Benzene	1.80E-04	1.72E-09	3.01E-08	2.10E-02	4.99E-11	0.00E+00
Total Pathway Risk					1.07-08	
Pathway Hazard Index						6.73E-05

Table 3. Adult Recreational Ambient Air Inhalation

Daily Dose (LADD or CDD) = (RME Conc. x IR x EF x ED) / (BW x AT) Carcinogenic risk = LADD x Slope Factor Hazard Quotient = CDD / Reference Dose					
<i>Contaminant</i>	<i>RME Conc. mg/m3</i>	<i>Lifetime Average Daily Dose mg/kg/d</i>	<i>Chronic Daily Dose mg/kg/d</i>	<i>Lifetime Cancer Risk</i>	<i>Systemic Hazard Quotient</i>
Tetrachloroethylene	1.11E-03	1.97E-07	3.44E-06	3.94E-10	3.44E-04
Trichloroethylene	4.10E-04	7.34E-08	1.28E-06	4.40E-10	2.14E-04
1,1-Dichloroethylene	1.20E-04	2.15E-08	3.76E-07	3.86E-09	4.17E-05
Tran-1,2-Dichloroethene	3.60E-04	6.44E-08	1.13E-06	0.00E+00	5.64E-05
Cis-1,2-Dichloroethene	1.20E-04	2.15E-08	3.76E-07	0.00E+00	3.76E-05
Bromodichloromethane	1.40E-04	2.50E-08	4.38E-07	1.55E-09	2.19E-05
Chloroform	1.10E-04	1.97E-08	3.44E-07	1.59E-09	3.44E-05
1,1-Dichloroethane	4.20E-04	7.51E-08	1.32E-06	0.00E+00	9.39E-06
1,2-Dichloropropane	1.20E-04	2.15E-08	3.76E-07	1.46E-09	3.42E-04
Vinyl Chloride	1.39E-03	2.49E-08	4.35E-06	7.451E-08	0.00E+00
Benzene	1.80E-04	3.22E-08	5.64E-07	9.34E-10	0.00E+00
Total Pathway Risk				8.48E-08	
Pathway Hazard Index					1.10E-03

DISCUSSION

EPA attempts to manage risks in the range of 1 in 10,000 ($1E-4$) to 1 in 1,000,000 ($1E-6$); risk levels below 1 in 1,000,000 are considered *de minimus* or negligible and do not warrant any remedial action. As can be seen in the results above, the total risk per exposure pathway for carcinogenic chemicals does not exceed the action level of $1E-6$ nor does the hazard index per exposure pathway for noncarcinogenic exceed unity (1). Therefore, the water is safe. Again these numbers are conservative and are based on limited sampling data. Based on this limited information, the water from Rottenwood Creek poses no significant risk to the students at Southern Polytechnical College.

UNCERTAINTIES

As important as these risk numbers are in the risk assessment, this section would not be complete without a discussion of uncertainty. The uncertainty associated with a risk estimate is primarily the combination of the uncertainties associated with the exposure estimates and the uncertainties in the toxicity evaluation. Additional uncertainty is inherent in environmental sampling, largely because of the potential for uneven distribution of chemicals in the environmental media.

Risk associated with the future exposure pathways are only meaningful if the pathways are completed. For surface water pathway, such as found in Rottenwood Creek, the probability is very low that students will come in direct contact with the water for extended periods of time, be immersed in water up to their waists, or be able to swim in the creek. The other physiological parameters that are used come from the default assumptions that are published by the EPA in its Exposure Factors Handbook and may not necessarily reflect the exact make up of the student population, and are at best estimates based on statistical data.

There is also considerable uncertainty associated with the toxicity of mixtures. For the most part, the toxicities of constituent mixtures are unavailable. Rather, toxicity studies generally are performed using single constituents. By summing or adding the risk of each chemical to develop a total risk per exposure pathway, the tendency at low levels of exposure is to overstate the amount of risk.

The most significant uncertainties are associated with the toxicity values slope factors and reference doses. Toxicity values are derived from animal study data. Animals are exposed to large doses of chemicals to produce some effect. Resultant data is then extrapolated to predict a human response. However, humans are generally exposed to concentrations many orders of magnitude less and may not exhibit the same, if any, effect.

Finally, the limited availability of data for use in this risk assessment makes it difficult to feel certain that it represents the level of possible contaminants that would be found over time at the site. To reduce this uncertainty, additional sampling is necessary.

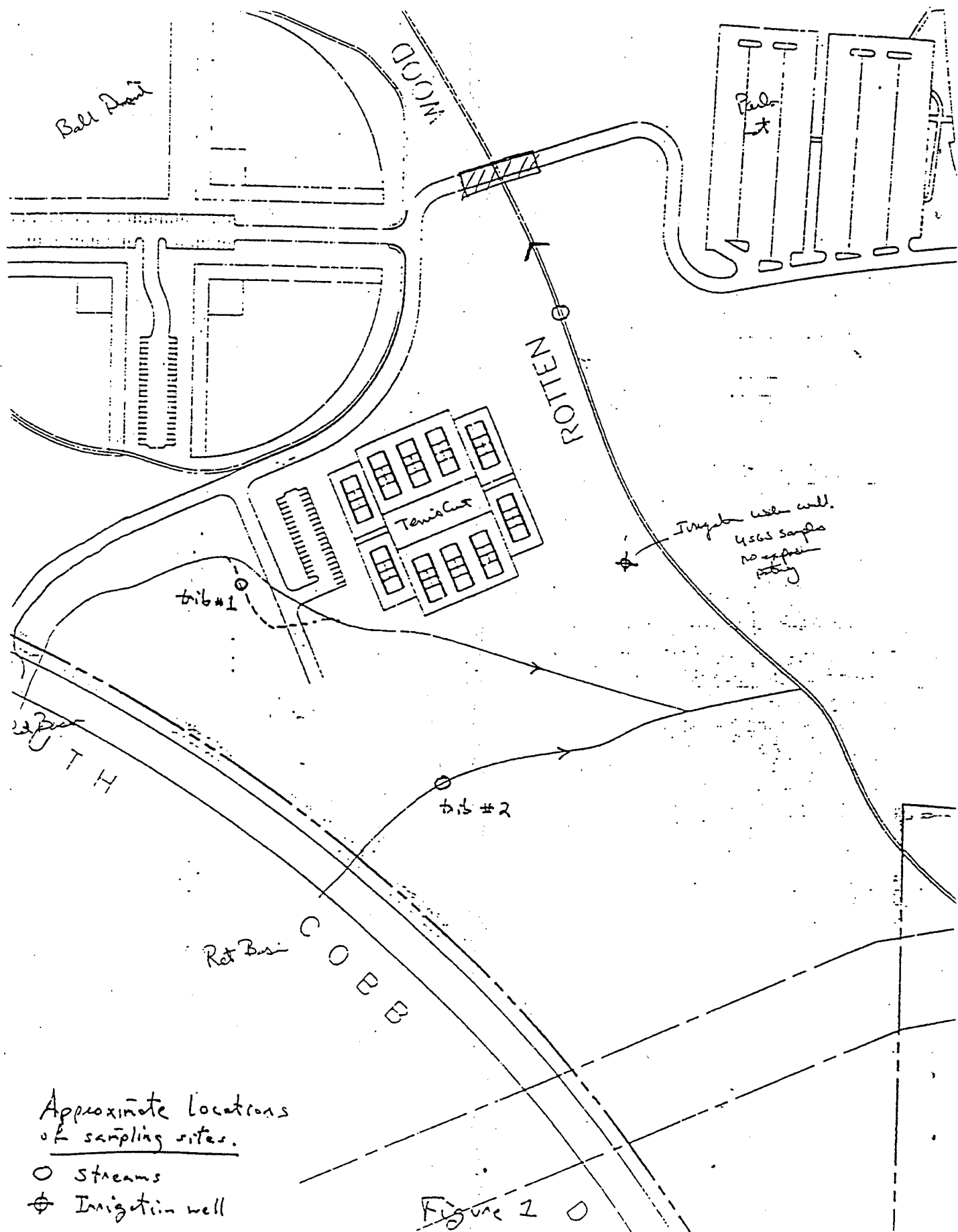
RECOMMENDATIONS

As a result of the above evaluation, we believe that no further action is required at this time. However, due to the potential for accidental discharge into Rottenwood Creek from AFP 6, we suggest that monitoring of those chemicals of potential concern be incorporated or continued in future sampling activities.

References

1. U.S. Environmental Protection Agency, Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part 1), Interim Final, Office of Emergency and Remedial Response, Washington, D.C., December 1989b.
2. U.S. Environmental Protection Agency, Region 4, Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment, Office of Emergency and Remedial Response, Atlanta, GA, November 1995.
3. U.S. Environmental Protection Agency, Region IX Preliminary Remediation Goals (PRGs) Second Half 1994, August 1, 1994
4. U.S. Environmental Protection Agency, Region III Preliminary Remediation Goals (PRGs) Second Half 1994, July - December 1995
5. National Research Council (NRC), Complex Mixtures, National Academy Press. Washington D.C., 1988.

Appendix 1. Sampling Locations Along Rottenwood Creek and Tributaries



Appendix 2: Historical Data, for Irrigation Well and Nearby Tributaries

Table 1. Concentrations of VOCs Detected in Water from Southern Technical Irrigation Well and in Nearby Streams

Sampling site	Sampling ID	Sampling date/time	Tetrachloroethylene	Trichloroethylene	1,1-Dichloroethylene	Trans-1,2-Dichloroethylene	Cis-1,2-Dichloroethylene	Bromodichloromethane	Carbon Tetrachloride	Chloroform	1,1-Dichloroethane	1,2-Dichloropropane	Vinyl Chloride	1,2-dichlorobenzene	Benzene
Southern Tech Irrigation Well	1	12/20/1994 1240	11.12	280	0.46	0.27	5.83	nd	0.01	0.88	0.17	nd	nd	0.15	nd
Southern Tech Irrigation Well	2	12/20/1994 1248	14.41	440	0.54	0.3	6.29	nd	0.12	0.94	nd	nd	nd	0.15	nd
Southern Tech Irrigation Well	3	12/20/1994 1254	10.95	340	0.41	0.27	5.5	nd	0.1	0.79	0.17	nd	nd	0.13	nd
Rottenwood Creek at Southern Tech below bridge near well		12/20/1994 1328	1.11	0.41	nd	nd	0.12	nd	nd	0.11	nd	nd	nd	nd	nd
Rottenwood Creek Tributary 1 above well site		12/20/1994 1350	nd	8.12	0.12	0.36	11.73	0.14	nd	0.48	0.42	0.12	1.39	nd	nd
Rottenwood Creek Tributary 2		12/20/1994 1400	0.11	16.6	nd	0.12	8.01	nd	nd	nd	nd	nd	0.12	nd	0.18

Note: Concentrations in micrograms per liter (ug/L); nd, not detected
 Bolded concentrations indicate values used in risk calculation